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Chronology and variability of Etruscan architectural terracotta

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Introduction: A tale of two roofs

Poggio Civitate is known to have had two distinct phases of monumental building projects (Phillips 1998). Structures in each phase utilized innovative terracotta tile technology in roof construction. Traditionally the Orientalizing phase is thought to have occurred between 675 and 610 BC and the archaic to have been between 600 and 480 BC (Phillips 1998). New luminescence dates provide empirical evidence that the Oriental phase began earlier than previously believed at 697 BC. These new dates provide evidence marking these architectural terracottas as the earliest on the Italic peninsula.

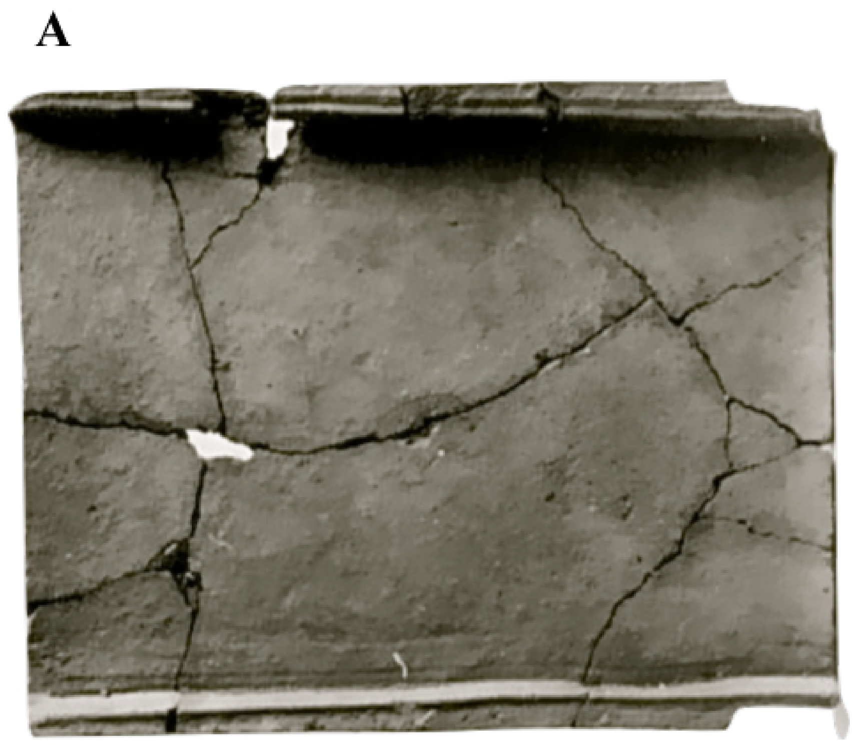
In addition, new work on the composition of the terracotta tiles using LA-ICP-MS provides a means to tracing the combinations of raw materials used in the manufacture process of tiles. These combinations appear to vary as well as repeat across samples of tiles and may represent a "technological meme" was replicated by these tilemakers. The repeated use of combinations of raw material and the differences between tile composition between each phase demonstrates changes in manufacturing recipes and, potentially, memes.

Aim: A new approach to an old problem

The aim of this project is to demonstrate the means by which it is possible to link measurements of variability in the material record to historical records through a combination of scientific analytical techniques analysis. By empirically validating dimensions of historical accounts (e.g., The exile and relocation of the Corinthian Demaratus in Dion. Hal. *Ant. Rom* 3.46.3-5; Livy 1.34.2; Plin. *HN* 35.43.152), it is then possible to utilize these events to provide context in the study of the timing and the nature of changes in material usage through time and across space.

One of the largest problems in classical or historical Archaeology is trying to link historically documented envents to empirically measurable atirubutes within the existing material record. Luminescence dating provides one such method as it directly measures the event of ceramic manufacture. In addition, by making measurements of elemental composition and monitoring changes through absolute chronology evaluations it is possible to track the patterns of technology innovation as they vary in terms of both time and space. Here, luminescence dating combined with elemental analyses enable us to measure technological changes in the manufacturing process of architectural terracottas and record how this innovative architectural technology changed from its initial introduction in the Etruscan area to its wide-scale adoption across the Italian peninsula.

A



B

Figures 1A and 1B: Two mostly complete terracotta pan tiles from the Archaic (A) and Orientalizing (B) periods.

Poggio Civitate (Murlo)

The site of Poggio Civitate is located 18 km SE of Siena, Italy just above the village of Vescovado di Murlo. Over the last 40 years of excavation archaeologists have unearthed the architectural foundations of the largest building to exist in the Mediterranean of it's time (~600-530 BC). Underneath this structure sits a complex of smaller buildings from the Orientizing period (~700-600 BC) complete with terracotta architectural revetments, Over the summer of 2007 portions of roof tiles from both phases were sampled to be dated by OSL and analyzed by TOF-ICP-MS to gain information on the details of how roof tile technology has changed over time.

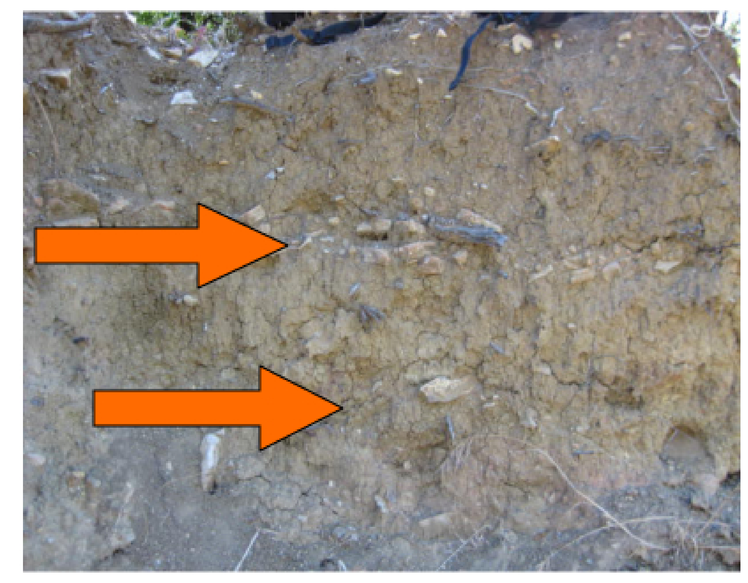


Figure 4: *Stratigraphy of Poggio Civitate. There are two distinct destruction layers covered by subsequent fill and floor packing.*

OSL and ICP-MS: Tools of the trade

Luminescence dating specifically measure the date at which a ceramic was fired. At this point, the luminescence "clock" is zeroed and luminescence begins to accumulate in various minerals in the ceramic paste that makes up the tile. The relatively high precision and accuracy of this technique allows for ceramics to be placed within tightly gouped age brackets. This kind of precision is required to resolve events related to the manufacturing of ceramics that were only made for short durations of time such as a roof tile.
In addition to generating dates for manufacture events, I will also be looking at the of chemical composition of the tiles themselves. Laser ablation TOF-ICP-MS is a robust analytical technique that allows for traces of rare earth elements to be measured at a relatively high degree of precision. Trace elements are used to determine the provenience of clays used in the manufacture of ceramics. This method, coupled with luminescence dating, will allow me to examine the changes in the materials used for the manufacture of these tiles over time. Changes in manufacture materials can lead to several hypotheses from an influx of new peoples ideas, to a discovery of a new more refined source of materials. LA-TOF-ICP-MS coupled with luminescence dating is an inexpensive, fast, and precise means of resolving any changes in the manufacturing materials over a period of time. The information gathered in this study provides the record with new details on the evolution of building practices in Etruria as well as Italy.

Fine Grain Sample Preparation

1 Calculate percent water absorption
2 Remove outer 2mm of sample using Dremel
3 Crush sample and disaggregate sample in shaker mill
4 Treat samples with HCL and H2O2 to remove carbonates and organics.
5 Settle 1-9 micron particles using Stokes Law.
6 Settle fine grain materials on stainless steel disk.

OSL/SAR Sequence (BOSL)

1 Preheat sample to 240 C for 10 seconds
2 Give dose, D1, for 5s
3 Preheat sample to 240 C for 10s
4 Stimulation with infrared light at 125 C for 50s
5 Stimulation with infrared light at 200 C for 50s
6 Stimulation with blue light at 125 C for 100s
7 Measure OSL (natural signal)
8 Give test dose, Dt, for 15s
9 Heat reduced to 160 C for 5s
10 Stimulation with infrared light at 125 C for 50s
11 Stimulation with infrared light at 200 C for 50s
12 Stimulation with blue light at 125 C for 100s
13 Measure OSL (regenerated signal)
14 Repeat steps 2-13

Annual dose and composition analysis

1. Sample ball mill to ~5μm
2. Mix with 40 ppm Indium internal standard and homogenize with briquetting additive.
3. Press mixture into wafer using 15-ton press.
4. Resulting wafer is measured for 46 elemental isotope concentrations using an GBC OptiMass 8000 TOF-ICP-MS coupled with a New Wave UP-213 laser ablation system.
5. Replicates of 5 second acquisitions were averaged and recorded wit standard error
6. All intensity counts were normalized against the external standards: NIST SRM612 and 610 glass, NIST SRM679 brick clay and New Ohio Red clay
7. Measured K, Th, and U values are used to calculate years since the last zeroing event (i.e. year of manufacture)
8. All analytes are entered into Guass statistical analysis program for grouping statistics.
9. Resulting data are subjected to variable biplots and principal component analyses and groups are separated

Figure 2: Site plan of the Orientalizing (red) and Archaic (purple) structures on the arx of Poggio Civitate (Murlo), Italy. Each phase demonstrates that terracotta tiles were utilized during roof construction.

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Results: Turning tiles into time

Sample ID	Mineral Type	Sample Prep Technique	Paleodose	Error (+/-)	Building Phase	Date (BC)	Error (+/-)
LB0168	Polymineral	Fine Grain	24.35	1.28	Orientalizing	697	182
LB0169	Polymineral	Fine Grain	22.5	0.67	Archaic	559	117
LB0170	Polymineral	Fine Grain	28.93	2.76	Orientalizing	639	269
LB0175	Polymineral	Fine Grain	19.77	0.41	Archaic	577	100
LB0177	Polymineral	Fine Grain	23.6	0.71	Archaic	569	125
LB0184	Polymineral	Fine Grain	28.45	0.37	Orientalizing	587	92

Table 1: *OSL results.*

The dates shown in Table 1 are a preliminary subset of a larger group that highlight the main objectives of this experiment. Each group clearly represents their respective construction phase and although LB0184 (587 +/- 92 BC) does not fit into Phillip's (1998) relative age range, it is clearly of an earlier date than those of the Archaic phase.

In order to generate an age, the paleodose for each sample calibrated against the naturally accumulated radiation with the tile itself. The annual dose was calculated by measuring the K, Th, and U concentrations by ICP-MS of the soil deposit excavated in tandem with each tile. Since the collected sediments were from two distinct soil matrices, the Th and U values in each matrix were averaged and used throughout that particular group. However there is unfortunately lots of variability among the measured K values for each matrix replicate. Because of this K was not averaged along with Th and U, instead each measured K value from the original corresponding sediment sample was used.

Resulting isotopic concentration values of clay pastes from both construction phases of Poggio Civitate were subjected to a series of statistical analyses. Both principal component analyses and bivariate scatterplots illustrate the lack of variability between the two groups. Both groups of tile clay pastes fall into one discriminant grouping indicating that the same clay was utilized for both construction phases.

A

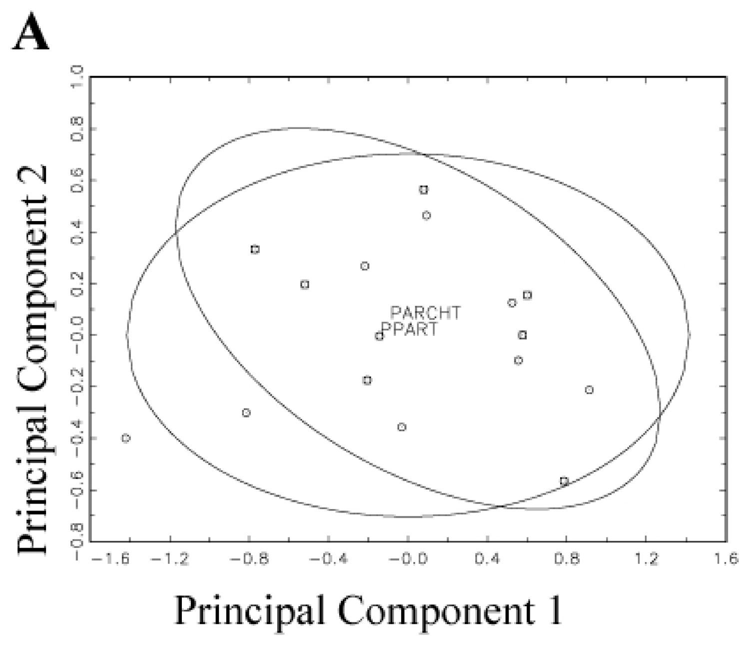

Figure 3A: *Principal component analysis indicating the tight compositional relationship between both the earlier Orientalizing construction phase and the later Archaic construction phase.*

B

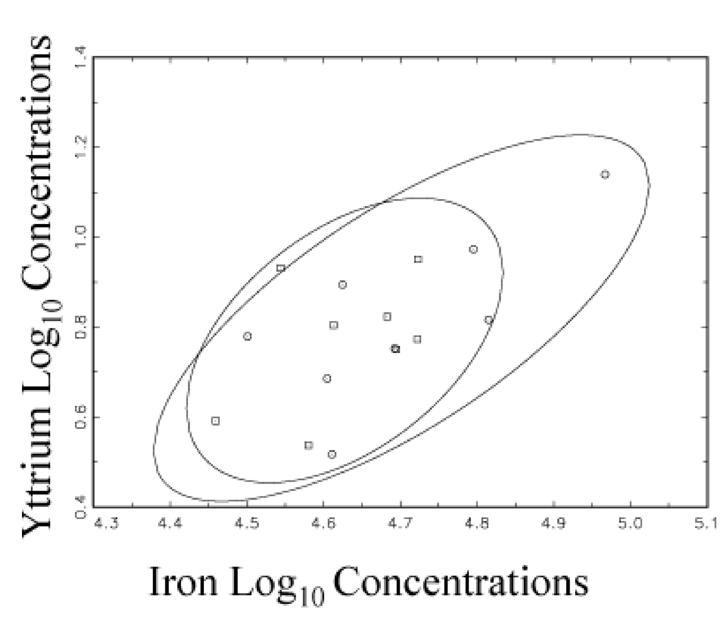

Figure 3B: *Bivariate scatter plot illustrating the lack of variability between both building phases. This lack of variability suggests that the same material was used in the manufacture of roof tiles. (Ellipses on both figures are at 90% confidence.)*

The paleodose for each sample measured by OSL were a result of 3-4 aliquots averaged. Each paleodose was converted into a dates using K, Th, and U concentrations measured by TOF-ICP-MS. The tight aliquot grouping and the lack of background noise in the luminescence, and the low error estimate values all illustrate the confidence of the paleodose values. Any disparity of calibrated dates within a group is therefore not a function of the measured paleodose but of it's dosimetry.

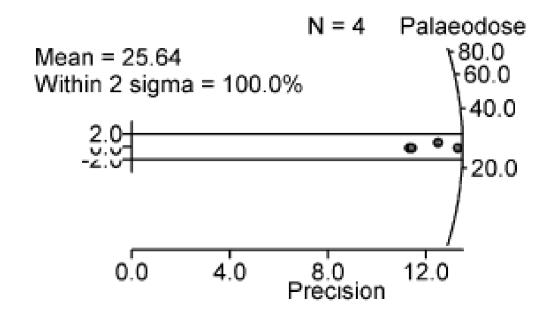

Figure 4: *Radial plot grouping 100% of aliquots for sample LB0168 within 2σ.*

Conclusions:

The aim of this experiment was to link a known event that had been recorded in ancient history to the surviving archaeological record. In doing so, combinations of tile paste compositions were traced through time to distinguish that there is indeed a traceable pattern, a "technological meme," of tile manufacture techniques over time. This indicates that there was likely a passing down of technological knowledge from one generation of ceramic workers to the next connecting any variation within manufacture techniques to the preferences of the different potters. The lack of significant variation in the tile paste recipes over the course of 250 years suggests that the clay was of a preferred consistency and probably harvested from a local claybed. Further spectral analysis of the local claybeds are forthcoming and are expected to favor this hypothesis. Furthermore, by following patterns in terracotta tile paste variation over a period of time and linking the results to historical accounts it is possible to construct an image of when Etruscans began using architectural terracotta technology and how they came upon the knowledge.

Acknowledgements

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References

Dionysius of Halicarnassus. *Roman Antiquities. 3.46.3-5.*
Livy. *The History of Rome. 1.34.2*
Pliny the Elder. *Natural History.* 35.43.152

Phillips, K. M., Jr. (1993). *In the Hills of Tuscany: Recent Excavations at the Etruscan Site of Poggio Civitate (Murlo, Siena).* Philadelphia, The University Museum, University of Pennsylvania.

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